SENSITIVITY AND COST OF MONITORING GEOLOGIC SEQUESTRATION USING GEOPHYSICS

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Monitoring of geologic sequestration projects will be needed in order to manage the process of filling the reservoir, verify the amount sequestered in a particular volume, and detect leaks. This paper discusses the applicability of geophysical methods, including seismic, electromagnetic, and gravity methods. Applicability is discussed in terms of the sensitivity and cost of the methods with particular focus on leak detection. The sensitivity of geophysical methods depends, first of all, on the contrast in geophysical properties produced by introduction of CO_2. Rock physics models were used to calculate anticipated contrasts in seismic velocity and impedance, electrical resistance, and density, in oil, gas and brine saturated rock when CO_2 is introduced. The phase behavior of CO_2 has large effects on property contrasts over the depth and temperature range of interest in geologic sequestration projects. Detectability depends critically on the resolution of the method. Numerical simulations were performed to evaluate how small a volume of CO_2 could be detected in the subsurface by geophysical methods. A realistic geologic volume containing heterogeneity was generated based on the Frio formation, a potential sequestration target in Texas. Reservoir simulation was used to model the movement of CO_2 over time into the volume. Geophysical simulation was then used to predict the response of surface-based seismic, electrical and gravity surveys. Results were processed using standard geophysical processing techniques and evaluated in terms of the geologic conditions that would influence the magnitude of a leak which could be detected. A preliminary evaluation of the cost of monitoring, using geophysical methods, was also carried out. Costs of performing 3-D land seismic surveys were estimated for a hypothetical project in which the CO_2 produced by a 1000 MW coal fired power plant is sequestered. Results indicate monitoring costs may be only a small percentage of overall geologic sequestration costs.